PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 12421080/RAB/MKA	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. **PCT/AU2004/000312**	International filing date *(day/month/year)* 12 March 2004	Priority date *(day/month/year)* 14 March 2003
International Patent Classification (IPC) or national classification and IPC **Int. Cl.** [7] G06T 11/00		
Applicant THE AUSTRALIAN NATIONAL UNIVERSITY et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. [X] *(sent to the applicant and to the International Bureau)* a total of **11** sheets, as follows:
      - [X] sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      - [ ] sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.

   b. [ ] *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or table related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

[X]	Box No. I	Basis of the report
[ ]	Box No. II	Priority
[ ]	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
[ ]	Box No. IV	Lack of unity of invention
[X]	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
[ ]	Box No. VI	Certain documents cited
[ ]	Box No. VII	Certain defects in the international application
[X]	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of the report
13 January 2005	20 June 2005
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **MATTHEW HOLLINGWORTH** Telephone No. (02) 6283 2024

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/AU2004/000312

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:

☐ international search (under Rules 12.3 and 23.1 (b))

☐ publication of the international application (under Rule 12.4)

☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

☐ the international application as originally filed/furnished

☒ the description:

pages **1, 4-15** as originally filed/furnished
pages* **2, 3, 3A, 3B** received by this Authority on **13 January 2005** with the letter of **same date**
pages* received by this Authority on with the letter of

☒ the claims:

pages as originally filed/furnished
pages* as amended (together with any statement) under Article 19
pages* **16-22** received by this Authority on **13 January 2005** with the letter of **same date**
pages* received by this Authority on with the letter of

☒ the drawings:

pages **1-14** as originally filed/furnished
pages* received by this Authority on with the letter of
pages* received by this Authority on with the letter of

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages
☐ the claims, Nos.
☐ the drawings, sheets/figs
☐ the sequence listing (*specify*):
☐ any table(s) related to the sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

☐ the description, pages
☐ the claims, Nos.
☐ the drawings, sheets/figs
☐ the sequence listing (*specify*):
☐ any table(s) related to the sequence listing (*specify*):

* *If item 4 applies, some or all of those sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-35	YES
	Claims	36-53	NO
Inventive step (IS)	Claims	1-35	YES
	Claims	36-53	NO
Industrial applicability (IA)	Claims	1-53	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

- D1: US 5,831,633 A (VAN ROY), 3 November 1998

NOVELTY (N) and INVENTIVE STEP (IS) claims 36-53

Claims 36-53: These claims lack novelty and inventive step when compared to document D1, which discloses all the claims' features. See, for example, figures 6(a)-6(d) which, in combination with the "choice function" described in column 8, anticipate fractal image data as claimed.

The remaining claims are inventively distinguished from the prior art by their use of the output images of one iteration as the input images of the next.

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claim 48 is unclear, because it refers to "image data generated at each iteration," yet claim 45 (to which it is appended) does not define any iteration or iterative steps.

Claims 28, 30, 36, 43, 45 and 49 are not fully supported by the description. It is clearly stated that random selection or combination of the images is an essential aspect of the invention. These claims do not include this characterisation.

Claims 36, 41, 45, 49 and 51 are not fully supported by the description. Claim 45 claims any image data decomposable in the described fashion, whether or not that image data was thus composed. Hence, the claim is not seen to reflect the essential features of the invention as described in the specification. Similar comments apply to claims 36, 41 and 49.

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SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a V-variable fractal.

In particular, the present invention provides a V-variable fractal represented by fractal image data, where V is an integer greater than one and represents the number of constituent images available for iterative combination to generate the fractal. The images are combined in a random manner.

The present invention also provides image data representing a variable number n of constituent images randomly selected from a set of V images and iteratively transformed and combined in a random manner to generate said image data, with $V > 1$ and $1 < n \leq V$.

The present invention also provides a fractal generation process, including:

(i) randomly selecting images from a set of input images;

(ii) selecting transformation functions from a set of transformation functions;

(iii) generating transformed images by applying the selected transformation functions to the selected images;

(iv) generating an output image by combining the transformed images;

(v) repeating steps (i) to (iv) to generate a set of output images; and

(vi) repeating steps (i) to (v) using said set of output images as said set of input images to generate a new set of output images.

The present invention also provides a fractal generation process, including randomly selecting from a set of input images, transforming the selected images, and combining the transformed images to generate a set of output images, and iterative repetition of these steps using the set of output images of each iteration as the set of input images for the next iteration.

The present invention also provides a fractal generation process, including:

(i) randomly selecting images from a set of input images;

(ii) transforming the selected images; and

(iii) combining the transformed images to generate a set of output images;

wherein steps (i) to (iii) are repeated iteratively using the set of output images of each iteration as the set of input images for the next iteration, each output image providing a new fractal.

The present invention also provides a fractal generator, including:

an image selector for selecting M images from V input images;

a function selector for selecting a set of M transformation functions;

at least one image transformer for respectively applying the selected transformation functions to the selected input images; and

a compositor for composing an output image from the images output by said at least one image transformer;

wherein the fractal generator is configured to iteratively generate sets of V output images using the set of V output images of each iteration as the set of V input images for the next iteration.

The present invention also provides a fractal generation system, including an image selector for selecting images from a set of input images, and an image transformer for transforming the selected images to generate a set of output images, said system being adapted to provide said set of output images as the set of input images to iteratively generate fractal image data.

The present invention also provides fractal image data representing a combination of two or more constituent first images, each of said first images representing a random transformed combination of two or more constituent second images, each of said second images representing a random transformed combination of two or more constituent third images, each of said third images representing a random transformed combination of two

or more constituent fourth images, wherein each transformation includes at least one of translation and rotation.

The present invention also provides image data decomposable into at least four successive levels, wherein each level is composed of smaller data sets which are affine transformations of V basic sets.

The present invention also provides image data representing iterative transformation and combination of at least two images selected from a set of $V > 1$ input images, wherein image data generated at each iteration represents a combination of at least two smaller images, wherein each of said at least two smaller images represents an affine or projective transformation of image data generated at the previous iteration.

The present invention also provides Image data representing a V-variable fractal, wherein V is an integer greater than one that determines the maximum number of basic images that can be generated by:

(i) selecting constituent images of said image data;

(ii) applying one or more projective transformations to each of the constituent images to provide basic images;

(iii) selecting constituent images of the basic images; and

(iv) iteratively repeating steps (ii) and (iii) to provide a set of basic images from which said image data can be generated by iterative random selection, transformation and combination;

wherein one or more first basic images that can be generated by affine transformation of a second basic image are considered to provide one basic image.

The present invention also provides image data decomposable into a set of basic images by:

(i) selecting constituent images of said image data;

(ii) applying one or more projective transformations to each of the constituent images to provide basic images;

(iii) selecting constituent images of the basic images; and

(iv) iteratively repeating steps (ii) and (iii) to provide said set of basic images from which said image data can be generated by iterative random selection, transformation and combination.

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CLAIMS:

1. A fractal generation process, including:

(i) randomly selecting images from a set of input images;

(ii) selecting transformation functions from a set of transformation functions;

(iii) generating transformed images by applying the selected transformation functions to the selected images;

(iv) generating an output image by combining the transformed images;

(v) repeating steps (i) to (iv) to generate a set of output images; and

(vi) repeating steps (i) to (v) using said set of output images as said set of input images to generate a new set of output images.

2. A fractal generation process as claimed in claim 1, wherein said output images represent respective fractals.

3. A fractal generation process as claimed in claim 2, including repeating step (vi) until said new set of output images is substantially independent of the first set of input images used in the process.

4. A fractal generation process as claimed in claim 1, wherein the number of selected transformation functions is less than the number of transformation functions in said set of transformation functions.

5. A fractal generation process as claimed in claim 1, wherein the step of selecting transformation functions includes selecting an iterated function system from a set of iterated function systems, each iterated function system including a set of transformation functions.

6. A fractal generation process as claimed in claim 5, wherein the selection of an iterated function system is based on selection probabilities associated with said iterated function systems.

7. A fractal generation process as claimed in claim 1, wherein the combining of said transformed images includes superimposing said transformed images.

8. A fractal generation process as claimed in claim 1, wherein said transformation functions include geometrical transformations.

9. A fractal generation process as claimed in claim 8, wherein said geometrical transformations include scaling and translation.

10. A fractal generation process as claimed in claim 8, wherein said geometrical transformations include scaling, translation and geometrical distortion.

11. A fractal generation process as claimed in claim 1, wherein said geometrical transformations are contractive transformations.

12. A fractal generation process as claimed in claim 1, wherein said transformation functions include projective transformations.

13. A fractal generation process as claimed in claim 1, wherein said transformation functions include transformations of at least one of brightness and colour.

14. A fractal generation process as claimed in claim 1, wherein each of said transformation functions is represented by one or more parameters.

15. A fractal generation process as claimed in claim 6, including generating said transformation functions and said selection probabilities.

16. A fractal generation process as claimed in claim 15, wherein said transformation functions and said selection probabilities are generated on the basis of one or more predetermined probability distributions.

17. A fractal generation process as claimed in claim 1, including generating said set of input images.

18. A fractal generation process, including randomly selecting from a set of input images, transforming the selected images, and combining the transformed images to generate a set of output images, and iterative repetition of these steps using the set of output images of each iteration as the set of input images for the next iteration.

19. A fractal generation process as claimed in claim 18, wherein said selecting includes selecting the same input image more than once.

20. A fractal generation process as claimed in claim 18, wherein said transforming includes scaling and translating the selected images.

21. A fractal generation process as claimed in claim 20, wherein said transforming also includes geometrically distorting the selected images.

22. A fractal generation process as claimed in claim 18, wherein the transforming is contractive.

23. A fractal generation process, including:

(iv) randomly selecting images from a set of input images;

(v) transforming the selected images; and

(vi) combining the transformed images to generate a set of output images;

wherein steps (i) to (iii) are repeated iteratively using the set of output images of each iteration as the set of input images for the next iteration, each output image providing a new fractal.

24. A system having components for executing the steps of any one of claims 1 to 23.

25. A computer readable storage medium having stored thereon program code for executing the steps of any one of claims 1 to 23.

26. Image data generated by a process as claimed in any one of claims 1 to 23.

27. Image data as claimed in claim 26, wherein said image data represents one or more V-variable fractals.

28. A fractal generator, including:

an image selector for selecting M images from V input images;

a function selector for selecting a set of M transformation functions;

at least one image transformer for respectively applying the selected transformation functions to the selected input images; and

a compositor for composing an output image from the images output by said at least one image transformer;

wherein the fractal generator is configured to iteratively generate sets of V output images using the set of V output images of each iteration as the set of V input images for the next iteration.

29. A fractal generator as claimed in claim 27, wherein said function selector is adapted to select said set of M transformation functions from N sets of transformation functions.

30. A fractal generation system, including an image selector for selecting images from a set of input images, and an image transformer for transforming the selected images to generate a set of output images, said system being adapted to provide said set of output images as the set of input images to iteratively generate fractal image data.

31. A fractal generation system as claimed in claim 30, wherein said image transformer includes one or more image transformation modules for transforming said selected images, and an image combination module for combining the transformed images.

32. A fractal generation system as claimed in claim 31, wherein said one or more image transformation modules are adapted to scale and translate said selected images.

33. A fractal generation system as claimed in claim 32, wherein said one or more image transformation modules are adapted to geometrically distort said selected images.

34. A fractal generation system as claimed in claim 30, including a transformation selection module to select transformations to be applied to the selected images from a set of transformations.

35. A fractal generation system as claimed in claim 34, wherein said transformation selection module is adapted to select transformations based on selection probabilities associated with said set of transformations.

36. Fractal image data representing a combination of two or more constituent first images, each of said first images representing a random transformed combination of two or more constituent second images, each of said second images representing a random transformed combination of two or more constituent third images, each of said third images representing a random transformed combination of two or more constituent fourth images, wherein each transformation includes at least one of translation and rotation.

37. Fractal image data as claimed in claim 36, wherein each transformation is a projective transformation, such as an affine transformation.

38. Fractal image data as claimed in claim 37, wherein each transformation includes contractive scaling.

39. Fractal image data as claimed in claim 37, wherein the transformations are contractive on average.

40. Fractal image data as claimed in claim 36, wherein each combination is a superposition.

41. Image data representing a variable number n of constituent images randomly selected from a set of V images and iteratively transformed and combined in a random manner to generate said image data, with $V > 1$ and $1 < n \leq V$.

42. Image data as claimed in claim 41, wherein the constituent images are transformed using projective transformations at each iteration.

43. A V-variable fractal.

44. A V-variable fractal as claimed in claim 43, wherein said V-variable fractal is represented by fractal image data, where V is an integer greater than one and represents the number of constituent images available for iterative combination to generate the fractal.

45. Image data decomposable into at least four successive levels, wherein each level is composed of smaller data sets which are affine transformations of V basic sets.

46. Image data as claimed in claim 45, wherein the basic sets vary from level to level.

47. Image data as claimed in claim 45, wherein the transformations are contractive.

48. Image data as claimed in claim 45, wherein said image data generated at each iteration comprises a set of $V>1$ images.

49. Image data representing iterative transformation and combination of at least two images selected from a set of $V > 1$ input images, wherein image data generated at each iteration represents a combination of at least two smaller images, wherein each of said

at least two smaller images represents an affine or projective transformation of image data generated at the previous iteration.

50. Image data representing a V-variable fractal, wherein V is an integer greater than one that determines the maximum number of basic images that can be generated by:

(v) selecting constituent images of said image data;

(vi) applying one or more projective transformations to each of the constituent images to provide basic images;

(vii) selecting constituent images of the basic images; and

(viii) iteratively repeating steps (ii) and (iii) to provide a set of basic images from which said image data can be generated by iterative random selection, transformation and combination;

wherein one or more first basic images that can be generated by affine transformation of a second basic image are considered to provide one basic image.

51. Image data decomposable into a set of basic images by:

(v) selecting constituent images of said image data;

(vi) applying one or more projective transformations to each of the constituent images to provide basic images;

(vii) selecting constituent images of the basic images; and

(viii) iteratively repeating steps (ii) and (iii) to provide said set of basic images from which said image data can be generated by iterative random selection, transformation and combination.

52. Image data as claimed in claim 51, wherein at least four iterations are performed.

53. Image data as claimed in claim 51, wherein the one or more projective transformations are selected to provide the minimum number of basic images.